First Successful Chemical Study of Bohrium

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The discovery of ^{267}Bh with a half-life of ~17 s [1] makes it an ideal candidate for gas phase chromatographic separation studies with the OLGA system, since the typical separation time with this device is about 5 s. The experiment is based on the assumption that Bh behaves as a group 7 element. These elements form very volatile oxychlorides in HCl/O_2 (gas).

Between August 20 and October 26, 1999, the first half of an experiment to study Bh chemistry was performed at PSI, Switzerland. A 670 $\mu g/cm^2$ ^{249}Bk target, provided by LBNL, was irradiated with $^{22}Ne^{6+}$ at 118 MeV for a total beam dose of 3.0×10^{18} particles. Since the target contained $100 \mu g/cm^2$ of ^{159}Tb deposited on its surface, ^{179}Re was also produced, serving as a yield monitor for the chemical separation. The behavior of Bh was investigated at 180, 150, and also at 75°C where Re still passes through the column with greater than 80% relative yield. The reaction products were transported by He loaded with carbon aerosol to the gas chromatography system where they were oxidized at 1000°C by addition of HCl/O_2 gas to form the volatile chloride and oxychloride molecules. These molecules were then separated by isothermal gas adsorption chromatography (~3 s) on the interior of a quartz tube. The volatile species were then reattached to CsCl particles and transported to the ROMA (rotating wheel) counting system.

Two α-SF chains, two α-α chains, and one α-α-α decay chain, all attributed to the decay of ^{267}Bh, were observed at 180°C. At 150°C two α-SF chains were observed, and at 75°C no events were observed. Random correlations should not significantly contribute to the number of α-SF or α-α-α chains seen, but of the 2 α-α correlations seen, 1.2 are expected to be due to random correlations. The unambiguous identification of Bh after chemical separation allows us to conclude that like its lighter homologues, Bh forms a volatile oxychloride compound, presumably BhO_3Cl, and behaves like a typical group seven element.

Assuming the Bh compound to be BhO_3Cl and applying a microscopic model of the adsorption-desorption process developed by Zvara [2], we evaluated the standard adsorption enthalpy of BhO_3Cl on the quartz surface: $\Delta H_{ads}(BhO_3Cl) = -77^{+10}_{-8}$ kJ/mol. This places Bh last in the series of the adsorption enthalpies of group 7 oxychlorides on quartz (Tc>Re>Bh).

After the quartz column BhO_3Cl was transported on CsCl aerosols. Unlike ReO_3Cl, TcO_3Cl is so volatile that is can not be transported with CsCl, which indicates Bh is more like Re than Tc.

Footnotes and References

* Heavy Element Collaboration: PSI, Switzerland; Universität Bern, Switzerland; NSD, LBNL; Chemistry Department, U.C. Berkeley; FLNR, Russia; FZR, Germany; GSI, Germany

1. P.A. Wilk, LBNL 1999 Annual Report (2000).
2. I. Zvara, Radiochimica Acta 38, 95 (1982).

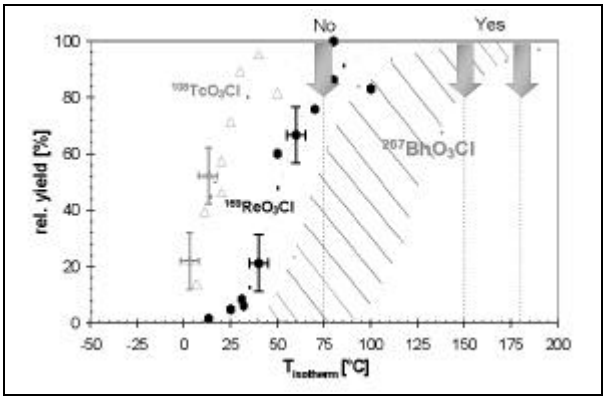

Fig. 1. Isothermal gas chromatography yield for the oxychloride species of Tc, Re, and Bh. Bh was observed at 180 and 150°C, but not at 75°C.